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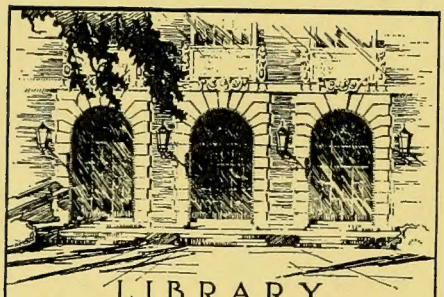

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SOME CONSERVATION PROBLEMS OF THE GREAT LAKES

Harlow B. Mills

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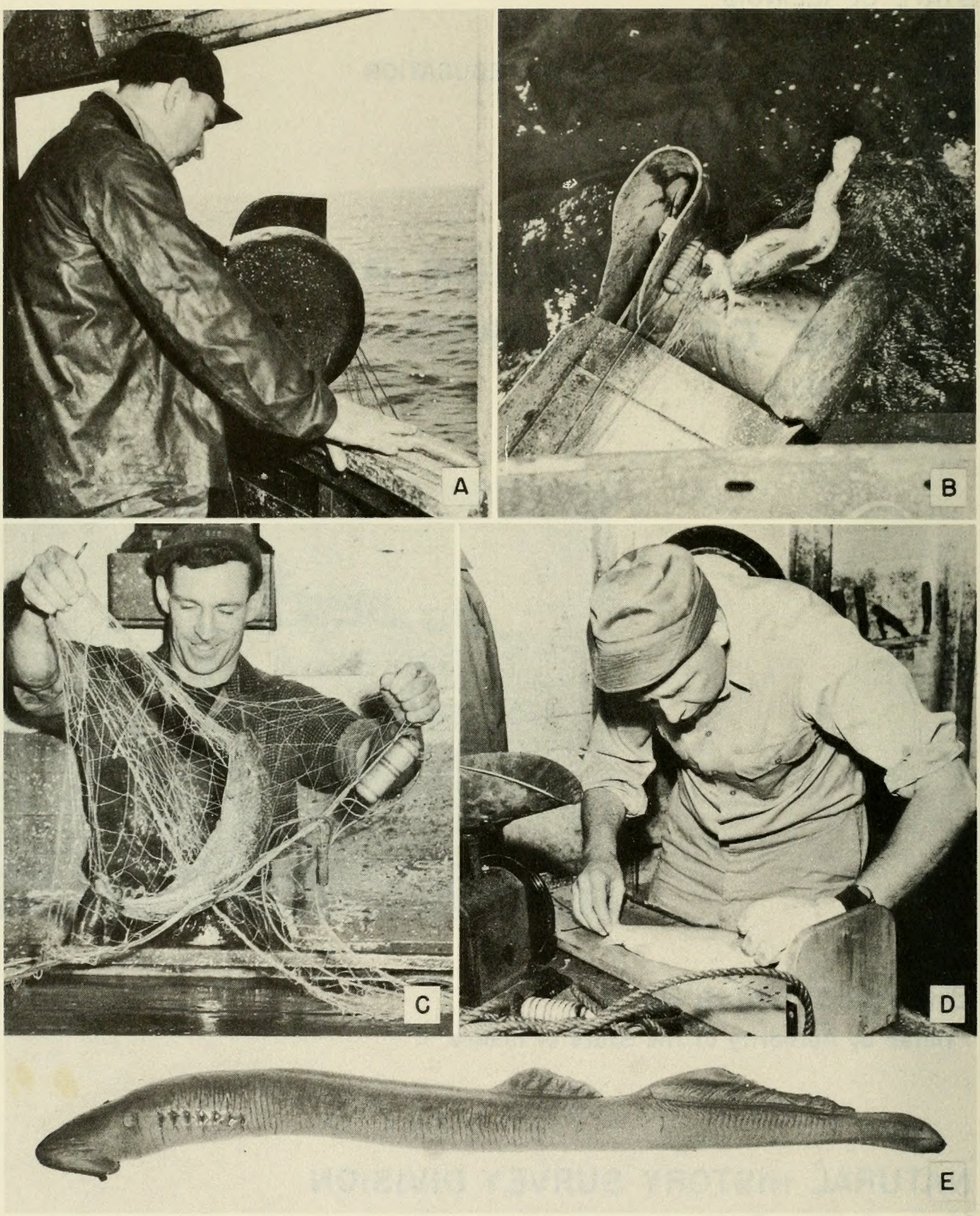

A and B.--Two views of net lifter in use on Lake Michigan fishing boat pictured on cover. C.--Removing fish from gill net hauled on to boat by net lifter. D.--Illinois Natural History Survey aquatic biologist measuring lake trout caught in Lake Michigan. E.--Sea lamprey, Petromyzon marinus.

SOME CONSERVATION PROBLEMS OF THE GREAT LAKES[1]

Harlow B. Mills

Like any word which has come into common use, conservation has many meanings to many people. Conservation is like the Grace of God; it is desired by the most of us and its high priests are many. Conservation is like a crack limited train; it has a point of origin and a destination, with a tight intermediate schedule. Conservation is like the more abundant life; it is aspired to by all. Conservation is like a copperhead snake; it appears unexpectedly and disrupts plans. Conservation is like an ancient prophet; it is a voice crying in the wilderness. Conservation is like a hard taskmaster; it demands the best, less than which is not enough. And finally, conservation is like a bandwagon; if we want to go somewhere we had best climb on.

Any word with the wide connotations possessed by this one is bound to be loved and hated by the same person, to be desired and feared, to be promoted and suppressed, to be a Gabriel and a Lucifer, and all at the same time. There is no resource which does not need conservation at some time or place. And there is no field in which conservation does not at times appear to be a bar to progress, an Old Man of the Sea to a Sindbad.

Conservation demands, therefore, a wide viewpoint, a synthesis of many needs, a sympathy for many ideals, and a humility which is hard for humans to attain.

The understructure of conservation is represented by science, by the development of knowledge. And science is compartmentalized. Mathematics, a blending of philosophy and science, is exact. It is predictable. If we do operation A, then B will follow and we cannot avoid it. Physics is less exact. Operation A in all likelihood will be followed by B. Chemistry embodies still less exactness. We know that A will be followed by B provided condition C applies. Biology begins to pick up variables in some numbers. Operation A will result in B or B- or B+ or B′ or B^2, depending on the many variables playing on the reaction. Cause and effect are snarled and difficult to untangle. A harmonious biological complex is like a great chord on an organ, consisting of many notes played at the same time. One note out of place will throw the whole chord into dissonance, and the discovery of the offending note is often extremely difficult.

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[1]Address given at the Joint Technical Program of the American Geophysical Union and the American Meteorological Society in a Symposium on the Natural Setting and Engineering Problems of the Great Lakes, Del Prado Hotel, Chicago, Illinois, September 11, 1952.

It follows, therefore, that when a field is complex, when it is beset with a swarm of gadfly variables, it is subject to personal opinion, to the development of statements unsupported by fact or at least only partially supported by fact, and subjectivity is likely to replace in part the more desired objectivity.

Workers in the physical sciences often speak of an apocryphal "fourth law" of thermodynamics to express the perversity of inanimate objects. Conservation biologists, in turn, have real need for an additional "fifth law" to express the fact that they seldom know what is going to happen when man starts tinkering with nature.

The Great Lakes are a resource upon which it would be hard to place a true value. This value is not only biological; it involves sociology and economics as well, and in these fields the plethora of variables makes biology look like a piker. However, it is the purpose of this paper to develop some of the conservation problems, largely biological, with as much objectivity as possible. And this assignment is no sinecure.

THE AQUATIC ENVIRONMENT

The aquatic environment in the Great Lakes is of greater importance to us than most persons realize. We haul iron ore over its surface from Minnesota to the various steel centers on the Lakes. This highway use is most important. But in time we may find that this use is a transitory thing. There will be no more ore to haul. The fisheries of the Lakes are another thing. They can be self perpetuating, and can continue into the future as long as nature or man allows the Lakes to continue.

Fish don't just happen in the nets of Great Lakes fishermen. Their occurrence is no accident. They hatch and grow up, and the growth cycle begins to gather the variables which we have referred to. There is an interdependence in this process which is highly complex, and years of study by several highly competent workers have done little else than gather important basic statistics. The philosophy of complexity in inland waters is dramatically illustrated by an article written by one of my predecessors, Dr. Stephen A. Forbes (1925). This paper, now 65 years old, is a biological classic, and should be read by biologists and physical scientists alike. Its title is "The Lake as a Microcosm," and in part it says:

> A lake is to the naturalist a chapter out of the history of a primeval time, for the conditions of life there are primitive, the forms of life are, as a whole, relatively low and ancient, and the system of organic interactions by which they influence and control each other has remained substantially unchanged from a remote geological period. . . . It forms a little world within itself--a microcosm within which all of the elemental forces are at work and the play of life goes on in full, but on so small a scale as to bring it easily within the mental grasp. Nowhere can one see more clearly illustrated what may be called the

> sensibility of such an organic complex, expressed by the fact that whatever affects any species belonging to it, must have its influence of some sort upon the whole assemblage. He will thus be made to see the impossibility of studying completely any form out of relation to the other forms; the necessity for taking a comprehensive survey of the whole as a condition to a satisfactory understanding of any part.

There are many factors which bring on this interdependency. To illustrate, let us discuss food for the moment. The fish of the Great Lakes live on neither air nor water nor love. There must be a source of food, and this source in turn must have its source, and so on down the line. A break anywhere in this food chain affects all of the organisms in both directions. A simplified food chain might be like this: Bacteria and diatoms are eaten by protozoans, these by small crustaceans, these by aquatic insects, these by fishes, and finally these by you and me at the next Elks Club smorgasbord. At this savory function it might be well to keep in mind that the pickled herring is actually an amalgam of the material remains of a billion departed germ ghosts.

Suppose now that there were a change in the environment which eliminated the microcrustaceans. What would happen? The insects dependent on them would die and in turn the fish population dependent on them would be depressed. On the other hand, the protozoa and bacteria which were held in check by the predatory pressure of the crustacea would find release, and, their reproductive capacity being what it is, they would fill the environment with a puree which would scatter consternation among the sanitary engineers and panic among the populace.

It should be understood that the above is a rank oversimplification. There are many short cuts and many other interrelationships which we have not considered. The actual situation has more than one dimension; it has three dimensions plus time. But in this simplification we have an illustration of the interdependence of organisms which can be grasped quickly.

THE GREAT LAKES FISHERY

We have implied that the fishery is an important biological resource of the Great Lakes. Let us now see what the resource actually is, and what it means to us.

The Great Lakes produce about 55 per cent of our total commercial catch, if we exclude the marine fisheries. According to Van Oosten (1949), virtually all of the high-priced fresh-water varieties produced in important quantities come from the Great Lakes. These include such species as the whitefish, lake trout, cisco, and chubs. The Lakes support a $12,000,000 fishing industry, as well as other industries allied to it. Furthermore, they provide sport fishing for hundreds of thousands of our citizens, and some localities count this as their principal source of income. Van Oosten (1949) further points out that the Lakes are in a highly strategic position as far as our popula-

tion is concerned. The cities of Milwaukee, Chicago, Detroit, Cleveland, and Buffalo are pressed against them. Nearly 53 million people, or 40 per cent of the total population of the United States, live in states fronting on the Lakes, and about 14 million or approximately 10 per cent in fronting counties.

Now, what is the status of this important fishing industry?

During a 40-year period, from 1879 to 1918, these bodies of water yielded an average of 101 million pounds of fish annually. Since that time the annual yield has fluctuated around 79 million pounds, a decrease of nearly one-fourth. The reduction in yield is accelerating with time. The average yield for the period 1940-1947 was about 75 million pounds annually, and since then there has been a calamitous reduction in catch of the highly prized lake trout. Concerning this we shall say more later.

The decline in yield has occurred in the face of an increased fishing fleet, more efficient equipment, extension of fishing grounds, the taking of rough, less desirable species, as well as the more desirable ones, and a liberalization of restrictions. An example of increased harvesting potential may be seen in a comparison of old and new fishing boats. Sailboats of the early fishery cruised about 10 miles from the shores; present power boats are limited in their cruising range only by waters too shallow for their draft.

If there were an unlimited supply of fish in the Lakes, the annual catch should have increased considerably, but this it did not do. Instead it dropped more than 22 per cent in the period following 1918.

The reduction of quantities of the better kinds of fishes resulted in an increased demand for the so-called "rough" species. Had this not been the case, and had not a substitution of poor for good been made, there would have been a further loss of 20 per cent. If we compare the period 1879-1903 with the period 1936-1945, this shift is abundantly apparent. The following tabulation, by lakes, gives interesting figures on the annual commercial catch:

Superior, rough fish increased from 20 to 80 per cent of the catch
Michigan, rough fish increased from 9 to 28 per cent of the catch
Huron, rough fish increased from 17 to 29 per cent of the catch
Erie, rough fish increased from 10 to 32 per cent of the catch
Ontario, rough fish increased from 38 to 60 per cent of the catch

Two reasons exist for this change: (1) an increase in rough fish production and (2) a decrease in fine fish production. Van Oosten (1949) has shown that the greater of these factors has been the loss of fine fish.

This is enough of statistics, probably, although statistics on fishes can hardly be called dry.

What brought about this drastic resource loss? Specifically, we are in

considerable doubt, but, theoretically, we can make some assumptions. To return again to Van Oosten (1949), we can quote his beliefs:

> Much of the reduced abundance in modern fishery must be attributed to overfishing or unwise fishing (cisco, whitefish, lake trout, chubs). Part of it we believe was caused by an infectious disease as was true for the smelt; part of it by the parasitic predator, the sea lamprey. Perhaps increased competition for space or food such as might have been brought about by the smelt in Lakes Huron and Michigan or the alewives in Lake Ontario may have played a role. Pollution, too, may have taken its toll. Often we have no better explanation to offer than to state that some unknown change in the environment was responsible.

Overexploitation has been listed as one cause of decimation in the Great Lakes. It would be difficult to explain the reduced yield in the face of increased advantage in any other way, unless there were other negative factors at work at the same time. However, the reproductive potential of most fishes is so great that they should hold their populations despite a good annual catch unless their reproductive activities are highly specialized and easily upset.

Overexploitation may be but one possible factor. With the progress of the times, the waters of the Great Lakes are continuously being manipulated, the bottoms changed, and the shore lines modified. These changes are bound to have some effect on the fishery. Changes in the physical environment are apparent and are continuing. We cannot have 10 per cent of our population in counties fronting the Lakes, and great industries developing on their shores, without changing in some way the character of the waters.

CHANGES IN THE PHYSICAL ENVIRONMENT

We may say that, due to the great expanse of the waters themselves, shore areas are of little importance. But we are wrong, for shores and shallows are of importance far beyond their proportionate area. In these shallower waters, temperatures rise to heights which allow the rapid growth of plankton, which we have indicated in the discussion of the food chain is an alimentary ancestor of fishes. In these waters aquatic plants can thrive, furnishing food and shelter. Fry and fingerlings of many species are at a much greater advantage in these situations than they would be in the open, deeper areas. And all catchable fishes must go through these juvenile states before they are netted, dressed, sold, and eaten by humans. Therefore, changes brought about by human encroachment on the shore lines may be of great importance to the fishery.

Dumpage of inert by-products of our civilization occurs in the Great Lakes. Dredging of materials from the bottoms goes on. Pollution of three kinds exists: (1) Domestic sewage is released into the Lakes, adding to the nutrients and subtracting from the dissolved oxygen. (2) Industrial sewage is released into the Lakes, causing injury or destruction to life in the waters. (3) The heavy utilization of the watershed for agricultural purposes has released silt into tributary streams, and this has changed the character of the bottom.

We may rationalize the use of the Great Lakes for disposal of domestic and industrial sewage by saying that the great quantities of water in the Lakes will dilute this sewage beyond the injury point. In this we can be very wrong. In the first place, the effect of sewage disposal is largely in the important shallow water areas. In the second place, sewage disposal may be in bays or other circumscribed areas where the dilution factor is small and certain waters can be converted into cesspools. All industrial sewage should be most carefully tested for possible injury to lake life, and tolerances established. The fact that an industrial effluent containing one part per million of deleterious material may not be injurious takes on new meaning when we increase the amount of effluent threefold in some partially isolated area.

Some species of fishes are dependent on streams for spawning and rearing their young. According to Langlois (1945), changes in fish populations in Lake Erie may have been due to the loss of such areas. Early records, he says, show that pickerel and muskellunge at one time ascended in the spring such rivers as the Huron, Maumee, and Sandusky for spawning purposes. Now such things as waste from an alkali plant, and greasy sludge, have established chemical barriers to fish movement. Silt, he further states, is particularly harmful. At the mouths of the Raisin, Maumee, Portage, and Sandusky rivers, silt deposits have eliminated most of the rooted vegetation by cutting off light, and consequently photosynthesis, and by actually suffocating plants through deposition of silt on their surfaces. The silt deposits have destroyed breeding grounds for several fishes and food for waterfowl, and the absence of these "aquatic meadows" has allowed increased wave action, which is cutting into the banks at the rate of 2 feet a year in some areas and much more in others. For example, at the Ohio-Pennsylvania line a clay bluff was cut back from 10 to 20 feet in one storm on November 2, 1942. Here is an interesting chain reaction: The tilling of soil in the watershed released silt, which washed into the rivers and was deposited in the estuaries, thereby destroying rooted aquatic vegetation, thereby increasing wave action, which greatly accelerated the erosion of the shore line.

The physical environment has changed in other ways. There have been diversions of waters, both into and out of the Great Lakes. The out-diversion at Chicago is well known. By law this flowage is limited to 3,100 cubic feet per second (1,500 c.f.s. direct flowage plus 1,600 c.f.s. domestic pumpage). My personal reaction to such regulation, even when approved by the Supreme Court, is that, wherein it is specific, rigid, and unchangeable, it is not based on good common sense. It reminds me a little of the man who, upon having trouble with his arithmetic, introduced a bill into a state legislature to make pi equal 3.0 instead of the more cumbersome 3.1416. It is well to legislate limits rather broadly, whether it be in the outflow of waters from Lake Michigan or the fish and game harvest. Changing conditions make specific legislation a precarious thing, and within limits someone should have the responsibility of fitting regulations to changing conditions. The limit of 3,100 c.f.s. is an arbitrary one, and, if we think this flowage greatly reduced the high water levels of 1952, we are not realistic.

There is also new flowage into the Great Lakes. In 1937, a diversion of

waters from the Hudson Bay drainage was instituted. A diversion of 1,400 c.f.s. by way of Long Lac into Lake Superior and another of 3,600 c.f.s. from Lake Nipigon into Lake Superior inaugurated in 1943 total to an inflow of 5,000 c.f.s. Langlois (1952) states that this diversion may have raised the level of Lake Erie by 3 inches.

Other waters have been tapped into the Great Lakes system through canal development. The Chicago Drainage Canal, Wabash-Erie Canal, Miami-Erie Canal, Ohio-Erie Canal, Erie Barge Canal, Welland Canal, and Trent Canal, all attach themselves to the Lakes. Even though they may have had no effect on levels, each has in it the possibility of changing the physical environment of the waters.

Then there are normal fluctuations in the Lakes. Tides occur, but they are of minor consequence; in Lake Michigan they apparently amount to a difference in levels of about 5 centimeters. More important than tides are fluctuations in levels resulting, it is thought, from such things as barometric pressures and winds. Langlois (1952) states that the extreme condition on Lake Erie occurred when the waters rose 7 feet at one end and lowered an equal amount at the other, making a total differential of 14 feet. These fluctuations are of considerable importance. They may affect the biological complexes in the Lakes directly or they may, through increased shore line erosion, affect them indirectly. Other changes in level, such as that represented by the high water of 1952, are apparently due to runoff from the watershed into the Lakes.

There are many other factors which have a bearing on the physical environment. Almost anything which changes the primitive picture in the watershed does this. The erection of dams, the building of weirs, the construction of levees, changes in the drainage pattern, all of these and other changes may, through chain reaction, affect the Great Lakes.

CHANGES IN THE FISH POPULATION

Now let us turn to the fish populations themselves. Are they the same as they were originally? If not, have any important changes taken place?

Not only have the physical factors undergone a shift, but the kinds and numbers of fishes have also. Several species are no longer important to the fishery. The blackfin chub, lake sturgeon, and lake trout in Lakes Huron and Michigan, and the Atlantic salmon in Lake Ontario have disappeared or have been greatly reduced in numbers.

On the other hand, other species have invaded in one way or another. The alewife, the smelt, the eel, the carp, the goldfish, the rainbow trout, the brown trout, the sea lamprey (which is not a true fish), and other smaller species have appeared in the waters. Some were purposefully placed there; others appeared accidentally or incidentally.

The alewife is a marine species which differs from its seagoing relatives

in size and in some physical characteristics. From Lake Ontario, which is directly connected to the Gulf of St. Lawrence, it is thought to have passed into Lake Erie through the waters of the Welland Canal. The new canal was opened first on April 20, 1931, and officially on August 6, 1931. A single specimen was reported by Dymond (1932) for Lake Erie on September 23 of the same year. Two years later the species was recovered in Lake Huron, but apparently it is not at all abundant in any of the lakes above Niagara. Its effect on other species is inadequately known. It is a forage species for lake trout, but whether it introduces any detrimental food or spatial competition is an open question.

The smelt was introduced in another way. After a couple of unsuccessful plantings, specimens from a landlocked population in New England were transferred to Crystal Lake in Benzie County, Michigan, in 1913. The purpose of this introduction was to provide more food for the indigenous lake trout. From Crystal Lake the smelt escaped into Lake Michigan, and on into Lake Huron. Whether or not smelts are important in the diet of lake trout has not been shown. They destroy lake shiners and in this way compete with the trout for food. They themselves, however, have added to the total commercial catch of the Great Lakes. From 1931 to 1939 the yearly catch of smelts averaged a little over a million pounds per year. From this amount, there were other increases until in the years 1940-1943 the catch averaged over 3.6 million pounds annually. In 1944 this fishery spectacularly collapsed, and only 4,500 pounds were taken. The smelt population built up again until in 1947 the take had increased to 786,000 pounds. The cause of this fluctuation is not specifically known, but Van Oosten (1949) believes that the spectacular decrease was caused by some unknown bacterial or virus disease.

Now we come to an entirely different denizen, the sea lamprey, which is not really a fish. It is a low vertebrate, and except for a free-living larval period it is entirely parasitic on fish. For a mouth, it is furnished with a sucking disc which is lined with sharp teeth. The lamprey fastens itself to a fish and rasps an opening into the body, from which it extracts blood and fragments of flesh. Lampreys have been recorded by several workers as attaching themselves to bottoms of boats, and they have been seen fastened to the hulls of lake boats passing from Lake Huron into Lake Superior. It is thought probable by many biologists that the introduction into the upper Great Lakes occurred in this manner through the Welland Canal.

Now we face this problem: Is the introduction and multiplication of the sea lamprey the cause of the remarkable reduction in fish production of the Great Lakes? As Langlois (1951) says, "These facts could explain the sudden drastic decline in the catch of lake trout." It may be significant that the least affected lake, Superior, still has the best trout fishery. Furthermore, there is good synchrony between the rise in lamprey numbers and the fall in trout numbers. But, as we have already said, the connection between cause and effect is often thoroughly snarled.

Popular interest in the sea lamprey has been largely in relation to the production of lake trout. The destruction of the trout fishery has been astound-

ing. According to Hile (1949), in the period 1895-1939, the United States trout catch in Lake Huron averaged 1,685,000 pounds annually. In 1949 the catch in this lake was 1,000 pounds, and in 1950 it was only 65 pounds (Hile 1951). For Lake Michigan the average annual take in the years 1940-1944 was 6.5 million pounds. In 1949 it had dropped to 342,000 pounds, and in 1950 to 54,000 pounds. For Lake Superior the catch has been more stable. In the United States waters of this lake the average annual take for more than 20 years before 1949 was a little over 3 million pounds. In 1949 the annual yield was just under 3 million pounds, and in 1950 it was nearly 3.2 million pounds.

Lampreys have some characteristics which cast some doubt on a direct cause-and-effect relationship. They show preferences, attacking most readily the dogfish. They will attack a dozen other species commonly, however, including the lake trout, but other species have varied in numbers without regard to the lamprey. These predators are seasonally selective, too. In the fall they seem to prefer yellow perch and walleyed pike. Furthermore, the attacks are not necessarily fatal to trout.

In the face of all of this information, we are led to wonder if the sea lamprey, despite the great notoriety which it has received in the past few years, is but one of the decimating factors instead of the decimating factor, as we are sometimes led to believe.

Now, if we consider only the three introduced species which we have discussed, we find that we are in doubt at every point as to the cause-and-effect relationships which may be involved. The picture is far from clear.

I hope that the above sketchy discussion will demonstrate that the aquatic environment of the Great Lakes is a complex one. That the governing factors are as yet poorly understood may be due in part to the fact that these conditions are constantly changing, even now, and other than a statistical base line is difficult to attain. We do not know what the pristine conditions were. And we have a woefully small group of specialists assigned to the role of cause-and-effect-unravellers.

SHORE LINE PROBLEMS

Finally, in this discussion of the conservation problems of these inland waters, I should like to refer quickly to another matter. Heretofore all of the discussion has been pointed toward the aquatic environment. Let us look at the shore line. There are important conservation problems here.

Now and then we read in the press, or in more formal publications, of questionnaires, which have been circulated among holders of lake frontage, seeking basic data on losses caused by high waters. These questionnaires, and the resulting compilations, leave me particularly unimpressed. Changes in water levels, and the resulting damage which they cause, are not acts of God. We can predict that they will occur, and in advance we know approximately the heights which they may reach. It is only common sense that certain strategic

areas must be given as complete protection from fluctuations in water levels as is possible. But landowners along the greater part of the frontage should consider that these fluctuations are normal and that any structures built in the area subject to fluctuation should be temporary or able to withstand the action of the high waters.

The condition is analogous to that in the flood plains of the larger rivers. We know that floods will come and, as certain as death and taxes, when these rivers decide to do a little reclaiming they will do it despite levees. This has been proved abundantly, and is gradually being accepted by the public. The Des Moines Tribune contained the following on April 22, 1952:

> Most dogmatic of all--and least welcome--are those who say nobody ever gets flooded unless he is rash enough to build a home or a business in the natural flood plains of rivers. The irritating thing about this last told-you-so is that it is true. In fact, it is a truism, because that is what a flood plain is--a place that floods occasionally, or has flooded. . . . . We are foolish to build on spots that are likely to be flooded every few years--or to rebuild. We are foolish to perpetuate attitudes toward river frontage that stem from the days when rivers were our sole easy routes for long distance freight and travel.

The Chicago Tribune printed an editorial on April 15, 1952, and we quote in part from it:

> It certainly doesn't cure anything at the moment, and it may seem cruelly pointless to tell a man who has just lost all his worldly goods that it is his own fault, but that is the fact. The people who are being flooded out gambled with the river. The river doesn't gamble. It may lie low for years, while foolish men move closer and closer to its banks and restrict its flow for their selfish purposes, but sooner or later it takes back its own. . . . . People tried to protect themselves against the river by building dikes and levees. The more they crowded the river, the higher they had to build. The higher they built, the more they crowded the river. Sooner or later, the river always wins. Then there is a great hullabaloo, and pork barrel congressmen cry for more millions. . . . . Only one thing is necessary to solve the flood problem: That is to give the river back its channel and its old flood plains. If the people want to build on them, or farm them, let them do so at their own risk, and not expect the government to bail them out, literally and financially, when the river takes over.

The above quotes deal with lake waters by close analogy. Now let us hear what Langlois (1952) has to say concerning an area on Lake Erie:

> There are short stretches of clay lands between Sandusky and Toledo, and these areas have been occupied by homes or cot-

> tages in spite of the risk of damage by bank wash or high water. . . . . This hazard was present when the land was reclaimed for residence, and it will increase with the gradual further submergence of the area. . . . . The flooding of the basin of Lake Erie is largely due to natural causes which are beyond human control. The harmful effects of this flood are due to the encroachment by people on the floodway--i.e., farming or building on lowlands close to the edge of the basin. The extent of damage to property is a measure of the extent to which people have encroached on the lake's flood plains. This is regrettable, but is an expression of lack of understanding of the natural hazards of this type of situation. Abandonment of such sites is strongly indicated, to avoid further damage.

Good conservation engineering, then, is not alone in the physical protection of low areas; it is also in warning and discouraging use of precarious areas without a clear knowledge and acceptance of possible consequence.

Throughout this discussion we have directly or indirectly stressed one thing--the ignorance of humans concerning their environment, especially as it relates to the area of the Great Lakes. We must constantly strive to overcome this ignorance, and it cannot be done in a short time or by a few people.

To return to our initial series of similes: conservation is like the blind men describing the elephant; to each it may appear to be something different. We shall continue to be blind men until we become conscious of our complete dependence upon our environment and its need for protection and perpetuation.

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